VARIATIONS OF *SPISSULA SOLIDISSIMA* DILLWYN

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The species that is the subject of this paper manifests certain pronounced variations. Verrill in 1872 noted (Report upon the Inv. Animals of Vineyard Sound, p. 358): ". . . there is great variation in the form of the shell, some being oval, others more oblong or elliptical, and others nearly triangular; some are swollen, others quite compressed, but all the intermediate grades occur." This observation can be made by anyone who examines even cursorily a series of mature shells. It might be of interest to have these variations mathematically expressed. The chief variations may be defined as follows: the degree of ovalness (the ratio of height to length); the degree of inequilateralness (the distance of the umbo from the center); the askewness (the angle formed by the greater and lesser diameters); and the obesity. This paper will discuss the first three, leaving the last for a subsequent essay.

This species is easily the most prominent molluscan feature of our east coast ocean beaches. Though in actual numbers it may be second to *Mytilus edulis* Linne, the latter is not so noticeable because of its much smaller size and definite localization on rocks, jetties and posts. *Spissula* is occasionally thrown upon our beaches in incredible numbers. Arthur Jacot (Naut. 34: 59f) estimated, after a violent winter storm, that no less than 5,000,000 animals to the mile had been cast up along a beach that extends five miles in either direction. Almost every winter, when severe storms undercut large reefs, our beaches are literally piled high with live bivalves, where, preserved by the natural refrigeration of winter, they provide a lasting feast for the gulls.

The shells represented in this study were collected at random on the beach at Rockaway, New York, care being taken however to reject valves too badly eroded or broken, and to limit the selection to shells of medium or large size. The shells studied varied in length from 182 mm. to 103.5 mm., the average size being 136.1 mm. Although no attempt was made to select right or left valves (actually there happened to be 54 left valves and 46 right), in no case were both valves of the same animal chosen.

Abnormal shells, shells that had been severely broken and subsequently repaired by the animal, where this repair work altered the outlines, or where damage to the mantle resulted in abnormal development of the ventral margin (cf. R. T. Jackson *Phylogeny of the Pelecypoda,* quoted by Chas. B. Davenport, *Am. Nat.* XXXIV, No. 407, p. 871)—such shells were discarded. However it must be understood that few if any of the shells examined were perfect, since the grinding action of wave and sand on such an exposed beach as Rockaway resulted in pronounced if unimportant imperfections. Thus in almost all cases the periostracum was largely or entirely removed, the ventral margin more or less severely chipped and the posterior shell structure surrounding the siphon—this being the area most frequently exposed to the action of the elements—was much battered, eroded and thickened. In some cases the interior of the shell disclosed an encysted mass of sand, which had probably been forcibly driven into the area between the mantle and the interior shell wall and had there been covered over with shell matter. One shell found (not included in this study) had its capacity reduced by as much as 20% (estimated) by such a sand cyst.

The tables given below will indicate mathematically the fact and extent of structural variation in the species. In most cases the tables need no explanation with the exception perhaps of the first. Here the clumsy term "umbo/length ratio" is used. By this is meant the ratio between the greater diameter (the length) and the distance of the umbo from the center of this line. To arrive at this figure the diameter is drawn and to it is dropped a perpendicular from the umbo. The distance from the point of contact to the center of the diameter is then measured and the ratio easily arrived at. If the umbo were perpendicularly above the center, the ratio would be zero. Hence a ratio of .163 shows a considerable degree of inequilateralness. The smallest ratio was found to be .030. The actual measurements of this distance varied from 28.5 mm. on a diameter of 182 mm. to 4 mm. on a diameter of 132 mm.

Ecologically the findings are without significance, since habitat data of all specimens studied are substantially identical. Nor, as table IV shows, is there any correlation between the two ratios discussed; thus a shell with the height/length ratio of .744 might

have an umbo/length ratio of anywhere between .037 and .157. Similarly an umbo/length ratio of .094 might have its corresponding height/length between .655 and .833. The findings, then, as far as the deduction of formulae or rules is concerned, are completely negative, and the author leaves in the hands of competent biologists and paleontologists the determination of the morphological significance of the variations studied.

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Table I

The first column expresses the umbo/length ratios, the second the number of shells for each ratio.

Ratio from			
.030–.034	2	.100–.104	6
.035–.039	3	.105–.109	3
.040–.044	3	.110–.114	7
.045–.049	1	.115–.119	2
.050–.054	7	.120–.124	1
.055–.059	1	.125–.129	2
.060–.064	1	.130–.134	5
.065–.069	5	.135–.139	2
.070–.074	5	.140–.144	3
.075–.079	7	.145–.149	3
.080–.084	5	.150–.154	0
.085–.089	4	.155–.159	2
.090–.094	5	.160–.164	1
.095–.099	13	.165–.169	1
		Total	100

The mean is .093, the standard deviation .032.

TABLE II

The first column represents the height/length ratios.

.650–.654	1	.750–.754	5
.655–.659	1	.755–.759	3
.660–.664	0	.760–.764	6
.665–.669	1	.765–.769	5
.670–.674	0	.770–.774	6
.675–.679	2	.775–.779	2
.680–.684	1	.780–.784	0
.685–.689	2	.785–.789	0
.690–.694	2	.790–.794	1
.695–.699	4	.795–.799	0
.700–.704	1	.800–.804	0
.705–.709	2	.805–.809	1
.710–.714	10	.810–.814	0
.715–.719	7	.815–.819	3
.720–.724	4	.820–.824	1
.725–.729	6	.825–.829	0
.730–.734	3	.830–.834	1
.735–.739	5		—
.740–.744	6	Total	100
.745–.749	8		

The mean is .737, the standard deviation .035.

TABLE III

In this table are represented the variations in the angle formed by the intersection of the greater and lesser diameters, i.e. the askewness of the shells.

Degrees	Shells	Degrees	Shells
90–94	7	105–109	23
95–99	27	110–114	6
100–104	37		—
		Total	100

TABLE IV

This table represents the correlation between the ratios of Table I and Table II.

Height/length ratios	Actual umbo/length ratios	Total shells
.650–.654	.102	1
.655–.659	.094	1
*.665–.669	.063	1
*.675–.679	.071, .079	2
.680–.684	.065	1
.685–.689	.079, .097	2
.690–.694	.119, .132	2
.695–.699	.042, .071, .078, .130	4
.700–.704	.068	1
.705–.709	.098, .108	2
.710–.714	.054, .053, .083, .094, .096, .100, .103, .101, .131, .163	10
.715–.719	.030, .058, .075, .083, .100, .114, .155	7
.720–.724	.044, .094, .097, .144	4
.725–.729	.030, .077, .097 (2), .114, .132	6
.730–.734	.038, .098, .112	3
.735–.739	.070 (2), .087, .092, .113	5
.740–.744	.037, .051, .053, .096, .116, .157	6
.749–.749	.044, .050, .065, .086, .089, .104, .113, .139	8
.750–.754	.082 (2), .099, .105, .148	5
.755–.759	.071, .097, .127	3
.760–.764	.052, .066, .076, .098, .109, .110	6
.765–.769	.035, .052, .120, .127, .146	5
.770–.774	.078, .081, .097, .114, .138, .144	6
.775–.779	.132, .144	2
*.790–.794	.147	1
*.805–.809	.049	1
*.815–.819	.069, .089, .160	3
.820–.824	.096	1
*.830–.834	.094	1
		100

* H/l ratios, not represented by corresponding u/l ratios, are omitted.